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Kristie A. Chambers
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Sir:

This is a request for filing a ☒ Continuation ☐ Divisional application under 37 C.F.R. § 1.60 of pending prior application Serial No. 08/653,520 filed May 15, 1995, of John P. Eckstein, Johnny Q. Zheng, Mark E. Nordness, Keith D. Lind, George H. Walbrun, Mary E. Shepard, Gregory K. Jones and Gregory J. Seeke entitled "Structures of Polymers Made from Single Site Catalysts".

- ☒ Attached is a true copy of the prior application (specification, claims, drawings, executed oath or declaration and any amendments referenced in the declaration), as originally filed. No amendments (if any) referred to in the oath or declaration filed to complete the prior application introduced new matter therein.
- ☐ A verified statement claiming small entity status ___ is enclosed or ___ is on file in the prior application and such status is still proper and desired (37 C.F.R. § 1.28(a)).
- ☐ A Preliminary Amendment is enclosed. No new claims have been added.
- ☒ Please cancel in this application original claims 9, 19-22, 27, 52-55 and 60 of the prior application before calculating the filing fee. At least one original independent claim is retained for filing purposes.

The filing fee is calculated on the basis of the originally-filed claims in the prior application as amended above:

			Small Entity			Large Entity	
	Number Filed	Number Extra	Rate	Fee		Rate	Fee
Basic Filing Fee				\$ 385.00	O R		\$ 770.00
Total Claims Filed	239 - 20	= 219	x 11	= \$ *		x 22	= 4818.00
Total Independent Claims	3 - 3	= 0	x 40	= \$ *		x 80	= 0.00
[X] MULTIPLE DEPENDENT CLAIMS PRESENTED			+ 130	= \$ *		+ 260	= 260.00
* If the difference is less than zero, then enter "0".			TOTAL	\$ *		TOTAL	\$5848.00

☒ Please charge the appropriate filing fee of \$5,848.00 to Deposit Account No. 13-0206.

☐ A check in the amount of \$.00 to cover the filing fee is enclosed.



- ☒ To maintain copendency, a Petition for Extension of Time and fee has been filed to extend the term in the pending prior application until July 2, 1997. A copy of the Petition for Extension of Time in the prior application is attached.
- ☒ During the pendency of this application, a Provisional Petition is hereby made under 37 C.F.R. § 1.136(a) for any extension of time required to ensure that any papers due in the U.S. Patent and Trademark Office are timely filed. Please charge the appropriate extension fees to Deposit Account No. 13-0206. A duplicate copy of this communication is attached.
- ☐ New drawings ☐ (___ Sheets) are enclosed.
- ☒ Please amend the specification by inserting before the first line, the following:
- This is a ☒ Continuation ☐ Divisional of U.S. Patent Application Serial No. 08/653,520, filed May 15, 1995.--
- ☒ This application discloses and claims only subject matter disclosed in the prior application(s). The inventor(s) in this application are:
- ☒ the same.
- ☐ less than those named in the prior application and it is hereby requested that the following inventor(s) identified above for the prior application be deleted: _____.
- ☐ This application discloses and claims **additional subject matter** by amendment. A new declaration or oath ☐ is attached ☐ will be filed. With respect to the prior application, the inventors in this application are:
- ☐ the same.
- ☐ less than those named in the prior application and it is hereby requested that the following inventor(s) identified above for the prior application be deleted: _____.
- ☐ Attached is a Petition to Suspend Prosecution For the Time Necessary to File an Amendment (New Application Concurrently Filed Herewith).
- ☒ The prior application is assigned of record to American National Can Company by assignment recorded on January 3, 1995, at Reel 7273 and Frame 569.
- ☐ Priority of Application Serial No. ___, filed on ___ in [country] is claimed under 35 U.S.C. § 119. A certified copy ☐ is enclosed or ☐ is on file in the prior application.
- ☒ The power of attorney in the prior application is to Thomas A. O'Rourke, Reg. No. 27,665. The prior application was recently transferred to the below-signing attorney. A new power of attorney will be forwarded shortly.
- ☒ The power of attorney appears in the original declaration of the prior application.
- ☐ Because the power of attorney does not appear in the original declaration, a copy of the power in the prior application is enclosed.
- ☐ A new power of attorney is enclosed.

- ☐ Recognize as associate attorney (Reg. No.).
- ☐ An Information Disclosure Statement is enclosed.
- ☐ Other: _____

AUTHORIZATION TO CREDIT OVERPAYMENT OR CHARGE ADDITIONAL FEES

The Commissioner is hereby authorized to charge any deficient fees or credit any overpayment of fees under 37 C.F.R. § 1.16 (filing fees) or 37 C.F.R. § 1.17 (application processing fees) that may be required now or during the pendency of this application to Deposit Account No. 13-0206. The Commissioner is not authorized to charge the issue fee unless/until an issue fee transmittal form is filed.

CORRESPONDENCE ADDRESS: Please direct all correspondence and telephone calls to: McDERMOTT, WILL & EMERY, 227 W. Monroe Street, Chicago, IL 60606; Telephone: (312) 372-2000.

Respectfully submitted,
McDERMOTT, WILL & EMERY

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IMPROVED STRUCTURES OF POLYMERS MADE
FROM SINGLE SITE CATALYSTS

BACKGROUND OF THE INVENTION

Polymeric materials have many applications in packaging structures. They are used as films, sheets, lidstock, pouches, tubes and bags. These polymeric materials may be employed as a single layer or one or more layers in a structure. Unfortunately, there are countless polymeric materials available. Furthermore, resin suppliers frequently have a tendency to claim many more applications for a product than the product is actually suitable for. In addition, in view of the specialized applications and processing problems that are encountered despite the suppliers claims, one skilled in the art can not tell whether a particular resin will be suitable for an application unless tested. However, for various reasons there are frequently drawbacks to the use of many of these polymeric materials. For example, ethylene vinyl alcohol is an excellent oxygen barrier material for use in packaging food products. However, this polymeric material can be affected by moisture that is present in the atmosphere or the packaged product. As a result, it is frequently found that some polymeric materials are better for certain applications than others.

One area where there is a need for suitable resins in film applications is in the area of heat shrinkable films. Heat shrinkable polymeric films are commonly used in

packaging meats, particularly primal meat cuts and other large pieces of meat. While this description will detail the usage of films for packaging meat and meat by-products, it will be understood that these films are also suitable for packaging a myriad of other products, both including food products and non-food products.

Some of the films embodying the present invention are intended to be used by meat packers in the form of heat shrinkable bags with one opened end, which bags are closed and sealed after insertion of the meat. After the product is inserted, air is usually evacuated from the package and the open end of the bag is closed. Suitable methods of closing the bag include heat sealing, metal clips, adhesives etc. Heat is applied to the bag once sealing is completed to initiate shrinkage of the bag about the meat.

In subsequent processing of the meat, the bag may be opened and the meat removed for further cutting of the meat into user cuts, for example, for retail cuts or for institutional use.

Suitable shrink bags must satisfy a number of criteria. Many bag users seek a bag that is capable of surviving the physical process of filling, evacuating, sealing and heat shrinking. For example, during the shrinking process great stress can be placed on the film by the sharp edges of bone in the meat. The bag must also have sufficient strength to survive the material handling involved in moving the large cuts of meat, which may weigh a

hundred pounds or more, along the distribution system.

Because many food products including meat deteriorate in the presence of oxygen and/or water, it is desirable that the bags have a barrier to prevent the infusion of deleterious gases and/or the loss or addition of moisture.

Conventional packaging for many products has frequently been made of multiple layer films having at least three layers. These multiple layer films are usually provided with at least one core layer of either an oxygen barrier material such as a vinylidene chloride copolymer, ethylene vinyl alcohol, a nylon or a metal foil preferably aluminum. Heat shrinkable meat bags, for example, have generally used vinylidene chloride copolymers. The copolymer of the vinylidene chloride may, for example, be a copolymer with vinyl chloride or methyl acrylate. Collapsible dispensing tubes have generally used one or more foil layers. The foil layers in addition to supplying an oxygen barrier also provide the dispensing tube with "deadfold", i.e., the property of a collapsible dispensing tube when squeezed to remain in the squeezed position without bouncing back.

Outer layers of films used in packaging food products can be any suitable polymeric material such as linear low density polyethylene, low density polyethylene, ionomers including sodium and zinc ionomers such ionomers include Surlyn, ethylene vinyl acetate etc. In conventional

shrink bags, the outer layers are generally linear low density polyethylene or blends thereof. Suitable outer layers for meat bags are taught by U.S. Patent No. 4,457,960 to Newsome, the disclosures of which are incorporated herein by reference.

While conventional films have been suitable for many applications, it has been found that there is a need for films that are stronger and more easily processed than conventional films. In meat bags, there is a need for films and bags that have superior toughness and sealability and the ability to undergo cross-linking without undue deterioration. Thus, it is an object of the present invention to provide improved structures, including single and multi-layer films, sheets, lidstock pouches, tubes and bags. In particular, structures for use in shrink bags wherein the shrink bags are capable of withstanding production stresses and the shrink process.

SUMMARY OF THE INVENTION

The structures of the present invention may be single or multilayer films, sheets, lidstock, pouches, containers, tubes and bags where at least one layer contains a polymer usually a copolymer formed by a polymerization reaction in the presence of a single site catalyst such as a metallocene. Examples of such a polymer are ethylene and propylene polymers and copolymers thereof. One preferred

copolymer is a copolymer of ethylene and an alpha olefin where such alpha olefin has a carbon chain length of from C₃-C₂₀. The structures of the present invention may also include blends of polymers and copolymers formed by a polymerization reaction with a single site catalyst or blends of a polymer and copolymer formed by a polymerization reaction with a single site catalyst and another polymeric material. Examples of suitable polymers for blending include: high and medium density polyethylene (HDPE, MDPE), linear low density polyethylene (LLDPE), low density polyethylene (LDPE), ethylene vinyl acetate (EVA), ultra low density polyethylene (ULDPE or VLDPE), and ionomers such as Surlyn.

The present invention may also be a multilayer structure of at least three layers wherein the core layer is a barrier layer. In one embodiment of the present invention, there may be a first outer layer of an ethylene or propylene polymer or copolymer formed by a polymerization reaction in the presence of a single ^{SITE}(cell) catalyst, a barrier layer and a second outer layer of a polymeric material. The second outer layer may be an ethylene or propylene polymer or copolymer formed by a polymerization reaction in the presence of a single site catalyst or a layer of another polymeric material such as high density polyethylene, medium density polyethylene, linear low density polyethylene, ultra low density polyethylene, low density polyethylene, ethylene vinyl acetate, an ionomer or

blends thereof. The first outer layer may also be a blend of the ethylene copolymer with another suitable polymeric material such as described above. A preferred polymer formed by a single site catalyst is a copolymer of ethylene and an alpha olefin such as octene-1. Additional layers such as adhesive layers or other polymeric layers may be interposed in the structure between one or both of the outer layers or on top of one or both of the outer layers. The structure of the present invention may be rendered oriented either uniaxially or biaxially and cross-linked by any suitable means, such as for example irradiation or chemical cross-linking.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of a three layer structure of the present invention.

Figure 2 is a side view of a five layer film of the present invention.

Figures 3-6 are examples of the structure of metallocene catalysts used in the polymerization of the polymer used in the structures of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The structures of the present invention include films, sheets, lidstock, pouches, containers, tubes and bags. These structures may be a single layer or multi-layer structure. The structures are comprised of polymers that

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have been polymerized in the presence of a single site catalyst, such as a metallocene. A metallocene is a complex organometallic molecule typically containing zirconium or titanium, with a pair of cyclic alkyl molecules. More specifically, metallocene catalysts are usually compounds with two cyclopentadiene rings fixed to the metal. These catalysts are frequently used with aluminoxanes as a co-catalyst or an activator, one suitable aluminoxane is a methylaluminoxane (MAO). Besides, titanium and zirconium, hafnium may also be used as the metal to which the cyclopentadiene is bonded. Alternative metallocenes may include Group IVA, VA and VIA transition metals with two cyclopentadiene rings. Also mono-cyclopentadiene rings or silyl amides may alternatively be in the metallocene instead of two cyclopentadienes. Other metals to which the cyclopentadiene may be attached may include the metals in the lanthanide series. Figures 3, 4, 5 and 6 show representative metallocenes that are suitable single site catalysts.

While the reaction mechanism is not completely understood, it is believed that the metallocene, single site catalyst confines the copolymerization reaction to a single site over the polymer thus controlling comonomer placement and side chain length and branching. The copolymers formed from metallocene single site catalysts are highly stereoregular products with narrow molecular weight distribution. The metallocenes can be used to polymerize ethylene,

propylene, ethylenic and acetylenic monomers, dienes and carbon monoxide. Comonomers with ethylene and propylene include styrene, substituted styrene, vinyl, acrylonitrile, methyl acrylate, methyl methacrylate and 1.4 - hexadiene. The metallocene single site catalysts are capable of producing isotactic polymers and syndiotactic polymers, i.e., polymers in which the crystalline branches alternate regularly on both sides of the back bone of the polymer. There are two general types of single site catalyst reactions. The first are nonstereoselective catalysts reactions which have been developed by Exxon and Dow and which are used to make Exxon's Exact resins and Dow's CGCT resins. See Figs. 3 and 4. The second type of reactions are stereoselective catalysts developed by Hoechst and Fina for stereo specific polymerization particularly of polypropylene and other olefins such as butene-1, and 4 methylpentene-1. See, e.g., Figures 5 and 6.

The ethylene alpha olefins polymerized by a single site catalyst have low crystallinity and a density that ranges from 0.854 to 0.97 gm/cc. Although this density range is similar to conventional ethylene polymers, i.e., LDPE, LLDPE and ULDPE, the polymers in the structures of the present invention have a narrow molecular weight distribution and homogeneous branching. The molecular weight distribution of the preferred polymers may be represented by the formula

$$MWD = M_w/M_n = <2.5$$

In addition, the melt processability of these polymers (I_{10}/I_2) has a range of about 5.5 to about 12 while conventional homogenous polymers are generally less than 6.5 at an MWD of 2. The melt tension of these polymers is in the range of about 1.5 to 3.5 grams.

The MWD of these polymers may be determined using a Waters's 150 GPC at 140°C with linear columns (103, A-10⁶ A⁰) from Polymer Labs and a differential refractometer detector. Comparison of the MWD of a 1MI, 0.920 density CGCT polymer with that of 1MI, 0.920 density conventional LLDPE illustrates the very narrow MWD of the CGCT polymers which usually have a M_w/M_n of approximately 2 compared to 3 or greater for LLDPE.

A preferred ethylene copolymer is a copolymer of ethylene and a C₃ to C₂₀ alpha olefin. A preferred copolymer is a low modulus ethylene octene copolymer sold by Dow. This copolymer is formed by Dow's constrained-geometry catalyst technology which uses a single site catalyst such as cyclo-pentadienyl titanium complexes. As best understood, Dow's constrained geometry catalysts are based on group IV transition metals that are covalently bonded to a monocyclopentadienyl group bridged with a heteroatom. The bond angle between the monocyclopentadienyl group, the titanium center and the heteroatom is less than 115°. When the alpha olefin is present in the copolymer in the range of about 10 to 20% by weight these copolymers are referred to as plastomers. When the percent alpha olefin is greater

than 20% these copolymers are called elastomers. The preferred ethylene octene copolymer has the octene comonomer present in an amount less than 25%. Examples of the Dow ethylene octene copolymer have the following physical properties.

<u>DENSITY</u> <u>g/cc</u>	<u>MOLECULAR</u> <u>WEIGHT DISTRIBUTION</u>	<u>MELT</u> <u>INDEX</u>	<u>MELT</u> <u>FLOW RATIO</u>	<u>MELT</u> <u>STRENGTH</u>
Polymer 1.				
0.920	1.97	1.0	9.5	1.89
0.910	1.90	1.0	7.9	1.68
0.902	2.10	1.0	7.6	1.68

Molecular weight distribution is defined as the ratio of weight average molecular weight to number average molecular weight. The lower the figure, the narrower the molecular weight distribution. Melt flow ratio is defined as the ratio of melt index, as tested with a 10-kg load to the melt index with a 2-kg load. The higher the ratio, the more processable the material. Melt flow ratio is defined as melt tension measured in grams. The higher the number the greater the melt strength. Other suitable resins are the Exact resins sold by Exxon, these resins have the following characteristics:

Property	Typical properties of Exact medical grade polyethylenes					
	Value by grade					
	4028	4022	4021	4023	4024	4027
Melt index (D1238)*	10	6	22	35	3.8	4
Density, g./cc. (D-1505)	0.880	0.890	0.885	0.882	0.885	0.895

Hardness (D-2240)						
Shore A	78	84	84	80	83	89
Shore D	29	35	36	27	35	39
Tensile strength at break, p.s.i. (D-638)	2220	1700	3260	620	2840	2200
Tensile elongation at break, % (D-638)	>800	>800	>800	>800	>800	>800
Tensile impact, ft.-lb./sq. in. (D-1822)	145	130	350	280	300	340
Flexural modulus, p.s.i. (D-790)	5040	4930	3980	3100	4180	7230
Vicat softening point °F. (D-1525)	138	168	158	138	158	181

a:ASTM test method

The structure of the present invention is comprised of an ethylene, propylene, or styrene polymer or copolymer formed by a polymerization reaction in the presence of a single site catalyst preferably a metallocene. Ethylene may be copolymerized with any suitable monomer such as $C_3 - C_{20}$ alpha olefin including propylene butene-1, 4-methyl pentene-1, hexene-1 and octene-1. A preferred comonomer is octene-1. The preferred ethylene alpha olefin copolymer of the present invention has a density in the range of .880 gm/cc to about .920 gm/cc, a more preferred range of .890 gm/cc to about .915 gm/cc and a most preferred range of about .900 gm/cc to about .912 gm/cc.

Figure 1 shows a cross section of a three layer coextruded structure. Layer 14 is the core layer which may be a barrier layer that minimizes the transmission of oxygen through the structure. Preferred barrier materials are polyvinylidene chloride copolymers such as copolymers of

vinylidene chloride and vinyl chloride or an alkyl acrylate such as methyl acrylate. Other preferred barrier material includes, ethylene vinyl alcohol, nylon or a metal foil such as aluminum. Layer 14 may also be a copolymer of ethylene and styrene formed using a single site catalyst in the polymerization reaction. The copolymer of vinylidene chloride may also be polymerized by the polymerization reaction in the presence of a single site catalyst. In addition, layer 14 may also be a polystyrene formed by a polymerization reaction in the presence of a single site catalyst. One such polystyrene is the crystalline syndiotactic polystyrene sold by Idemitsu Petro-Chemical Co., Tokyo, Japan.

On opposite sides of the core layer 14 of Figure 1 are layers 12 and 16. At least one of these layers 12 is a polymer formed by a polymerization reaction in the presence of a single site catalyst. The remaining layer 16 may be any suitable polymeric material such as a polyester, co-polyester, polyamide, polycarbonate, polypropylene, propylene-ethylene copolymer, ethylene-propylene copolymer, combinations of polypropylene and ethylene vinyl acetate copolymer, ultra low density polyethylene, low density polyethylene, medium density polyethylene, high density polyethylene, linear low density polyethylene copolymers, linear medium density polyethylene copolymer, linear high density polyethylene copolymer, ionomer, ethylene acrylic acid copolymer, ethylene ethyl acrylate copolymer, ethylene methyl acrylate copolymer, or ethylene methacrylic acid copolymer.

In an alternate embodiment, the layer 12 may be a blend of a polymer formed by a polymerization reaction in the presence of a single site catalyst and a suitable polymeric material such as is identified in connection with the description of layer 16 above.

As seen in Figure 2, the structure may also include embodiments which have a fourth layer 28 over the first layer 22 and a fifth polymeric layer 30 over the third layer 26. The composition of the fourth layer 28 may be selected from the same group of materials from which the composition of the first layer 12 or third layer 16 is selected, and the fifth layer 30 may also be the same composition as the first layer 22 or the third layer 26.

In an alternate embodiment of Figure 2, the five layer structure may have a first layer 28 similar in composition to layer 12 of Figure 1, i.e., the film may have a first layer of a polymer formed by the polymerization reaction with a single site catalyst or blends thereof with another suitable polymeric material. One or both of the second 22 and fourth 26 layers may be an adhesive layer.

The composition of adhesive layers 22 and 26 is selected for its capability to bond the core or barrier layer 24 to the surface layers 28 and 30. A variety of the well known extrudable adhesive polymers adhere well to the core or barrier layer 24. Thus, if for example layer 30 is a polypropylene, an adhesive polymer based on polypropylene is desirably selected for layer 26. Examples of such adhesives

are the extrudable polymers available under the trade designations Admer QF-500, QF550, of QF-551 from Mitsui Petrochemical Company, or Exxon 5610A2.

If the composition of layer 28 or 30 is an ethylene based polymer or copolymer, an adhesive polymer based on ethylene is preferably selected for layer 22, including ethylene homopolymer and copolymers. Such a preferred adhesive composition is an ethylene vinyl acetate copolymer containing 25% to 30% by weight vinyl acetate. Other ethylene based homopolymer and copolymers, modified to enhance adhesion properties are well known under the trade names of, for example, Bynel and Plexar. Typical base polymers for these extrudable adhesives are the polyethylene and the ethylene vinyl acetate copolymers. Such adhesive polymers, including the polypropylene-based polymers, are typically modified with carboxyl groups such as anhydride. Also acceptable as adhesives are ethylene methyl acrylate copolymers (EMA).

Additional layers may also be present in the structures of the present invention. For example, the present invention contemplates 4, 6, 7, 8, and higher numbers of layers in the film of the present invention and different combinations of layer structures may also be present. For example, there may be more than one barrier layer, i.e., two layers of polyvinylidene chloride copolymers, two layers of foil or two layers of EVOH or nylon. Alternatively, this may be a layer of EVOH and a layer of a polyvinylidene chloride copolymer or a polyamide or a polystyrene and other combinations of the

core materials. The additional layers of the present invention also encompass more than one polymer formed by the polymerization reaction in the presence of a single site catalyst. The polymers may be in a layer alone or in the form of a blend. Suitable polymers for blending with an ethylene polymer formed in a polymerization reaction with a single site catalyst include other ethylene polymers formed in a polymerization reaction with a single site catalyst, LDPE, LLDPE, ULDPE, EVA, ionomers, ethylene copolymers, ethylene methyl acrylate (EMA), ethylene acrylic acid (EAA), ethyl methyl acrylic acid (EMAA), polypropylene (PP), ethylene normal butyl acrylate (ENBA), ethylene propylene copolymers (PPE). Suitable polymers for blending with a propylene polymers formed in a polymerization reaction with a single site catalyst include ethylene propylene copolymers.

Preferred blends using EVA's are those having lower VA content as they tend to yield EVA layers having better hot strength. EVA's having higher VA content tend to yield EVA layers having increased adhesion to for example, the vinylidene chloride copolymer layer. EVA's having virtually any amount of VA will have better adhesion to the vinylidene chloride copolymer layer than an ethylene homopolymer. However, good interlayer adhesion is considered desirable in the invention, and thus, steps are usually taken to enhance adhesion where no unacceptable negative effect is encountered. Thus, higher VA contents, in the range of 6% to 12% vinyl acetate are preferred, a melt index of less than 1 is also

preferred. While blend amounts are shown herein in weight percent, VA contents are mole percent. Especially preferred EVA's have VA content of 7% to 9% and melt index of 0.2 to 0.8. Blends of EVA's to make up the EVA component of layers 16 and 18 are acceptable.

The structure of the present invention may be formed by any conventional process. Such processes include extrusion, coextrusion, extrusion coating, extrusion lamination, adhesive lamination and the like, and combinations of processes. The specific process or processes for making a given film which is neither oriented nor cross-linked can be selected with average skill, once the desired structure and compositions have been determined.

When the structure of the present invention is a film, the film may also be oriented either uniaxially or biaxially. Orientation can also be done by any conventional process for forming multiple layer films. A preferred process includes the steps of coextrusion of the layers to be oriented, followed by orientation in one of the conventional processes such as blown tubular orientation or stretch orientation in the form of a continuous sheet; both being molecular orientation processes. The double bubble technique disclosure in Pahlke, U.S. Patent No. 3,456,044 is suitable for use in producing the film of this invention. The films may also be formed by a tubular water quench process. In this process the film may be extruded downwardly as a tube formed by an annular die, and carried into a water quench tank,

generally with a cascade of water on the outside surface providing initial cooling. The flattened tape is withdrawn from the quench bath, is reheated (normally in a second water bath) to its orientation temperature, is stretched in the machine direction between two sets of rolls that are so rotated as to establish a linear rate differential therebetween, and is simultaneously oriented in the transverse, or cross-machine, direction as an inflated bubble trapped between the nips of the rolls. In accordance with conventional practice, the film will usually be cooled by air in the orientation zone.

The film of the present invention may also be oriented and/or cross-linked. The first step is the formation of a multiple layer film. The formation of the multiple layer film, is usually most easily accomplished by coextrusion of the desired layers. Other formation processes are acceptable so long as the resulting oriented film at the conclusion of fabrication processing is a unitary structure.

The second step is orienting the multiple layer film. One method for accomplishing orientation is by heating the film to a temperature appropriate to molecular orientation and molecularly orienting it. The film may then be optionally heat set by holding it at an elevated temperature while its dimensions are maintained. The orientation step is preferentially carried out in line with the first step, which is the film formation step of the process.

The third step is subjecting the formed and oriented

multiple layer film, to electron beam irradiation.

The amount of electron beam irradiation is adjusted, depending on the make-up of the specific film to be treated and the end use requirement. While virtually any amount of irradiation will induce some cross-linking, a minimum level of at least 1.0 megarads is usually preferred in order to achieve desired levels of enhancement of the hot strength of the film and to expand the range of temperature at which satisfactory heat seals may be formed. While treatment up to about 50 megarads can be tolerated, there is usually no need to use more than 10 megarads, so this is a preferred upper level of treatment the most preferred dosage being 2 to 5 megarads.

The third step of subjecting the film to electron beam irradiation is performed only after the multiple layer film has been formed, and after molecular orientation, in those embodiments where the film is molecularly oriented. It should be noted that, in the irradiation step, all of the layers in the film are exposed simultaneously to the irradiation sources, such that irradiation of all the layers of the film takes place simultaneously.

In one embodiment of the process, the second step of orientation may be omitted and the unoriented multiple layer film may be cross-linked by irradiation treatment to produce a cross-linked, unoriented, multiple layer film.

EXAMPLES

Multilayer films may be prepared according to the present invention. Biaxially stretched three layer films may be prepared by a "double bubble" process similar to that disclosed in U.S. Patent No. 3,456,044 by coextruding the following compositions through a multilayer die, biaxially stretching the coextruded primary tube. The films may also be irradiated if desired.

EXAMPLE 1

- Layer 1 - Copolymer of ethylene and an alpha olefin such as Hexene-1 or Octene-1 formed by the polymerization reaction in the presence of a single site catalyst or metallocene (hereinafter CEO)
- Layer 2 - Vinylidene chloride - methyl acrylate (VDC-MA) copolymer
- Layer 3 - Polyolefin. This film may be biaxially stretched and if necessary irradiated.

EXAMPLE 2

- Layer 1 CEO
- Layer 2 VDC-MA
- Layer 3 ULDPE-EVA blend

EXAMPLE 3

- CEO
- VDC-MA
- CEO

EXAMPLE 4

- CEO-EVA blend
- VDC-MA
- CEO-EVA blend

EXAMPLE 5

- LAYER 1 CEO
- LAYER 2 Nylon
- LAYER 3 CEO

EXAMPLE 6

- CEO
- Nylon
- ULDPE-EVA

EXAMPLE 7

- CEO-EVA blend
- Nylon
- CEO-EVA blend

EXAMPLE 8

- LAYER 1 Polyolefin
- LAYER 2 Styrene copolymer formed by the polymerization reaction with a single site catalyst

EXAMPLE 9

- Polyolefin
- Propylene copolymer formed by the Polymerization

reaction with a single
site catalyst

LAYER 3 Polyolefin

Polyolefin

EXAMPLE 10

LAYER 1 CEO
LAYER 2 CEO
LAYER 3 CEO

EXAMPLE 11

CEO
EVOH
ULDPE-EVA Blend

EXAMPLE 12

CEO-EVA Blend
EVOH
CEO-EVA Blend

EXAMPLE 13

LAYER 1 CEO
LAYER 2 Tie
LAYER 3 PVDC Copolymer
or EVOH
LAYER 4 Tie
LAYER 5 ULDPE-EVA Blend

EXAMPLE 14

CEO
Tie
PVDC Copolymer
or EVOH
Tie
CEO

EXAMPLE 15

CEO-EVA Blend
Tie
PVDC Copolymer
or EVOH
Tie
CEO-EVA Blend

EXAMPLE 16

LAYER 1 EVA-ULDPE
LAYER 2 ULDPE or CEO
LAYER 3 PVDC Copolymer or EVOH
LAYER 4 EVA
LAYER 5 CEO or blend of CEO and EVA

The following examples may also be prepared in
accordance with the present invention:

EXAMPLE 17

Meat Film - Forming Web
Formed by TWQ Process
(Tubular Water Quench Process)

LAYER 1 Nylon
LAYER 2 Tie
LAYER 3 EVOH
LAYER 4 Tie
LAYER 5 CEH or CEO

CEH is a copolymer of ethylene and Hexene-1 formed

by the polymerization reaction in the presence of a single site catalyst or a metallocene. Other alpha olefins can be polymerized with the ethylene also.

EXAMPLE 18-20

Innerliner Films - These films can be formed either on a blown film line or by using a tubular water quench.

LAYER 1 HDPE
LAYER 2 Blend of CEH or CEO and EVA and polybutylene

LAYER 1 HDPE
LAYER 2 CEH or CEO and polybutylene

LAYER 1 HDPE
LAYER 2 CEH or CEO

EXAMPLE 21 and 22

Meat - Non Forming Top Web film

LAYER 1 PVDC coated PET
LAYER 2 Adhesive (lamination)
LAYER 3 CEO or CEH

This film may be formed by adhesive laminating a film formed of a copolymer of ethylene and an alpha olefin with the PVDC coated PET film.

LAYER 1 PVDC coated PET
LAYER 2 LDPE - extrusion laminated
LAYER 3 LDPE/CEH or CEO coextrusion

This film can be formed by extrusion laminating a film of PVDC coated PET or LDPE.

EXAMPLE 23

Layer 1 - Blend of two or more copolymers of ethylene and an alpha olefin polymerized in the presence of a single site catalyst or metallocene such as CEO with either CEH or CEB. CEB is a copolymer of ethylene and butene-1 formed by a polymerization reaction in the presence of a single site catalyst or a metallocene.

EXAMPLE 24

Layer 1- Blend of a copolymer of ethylene and an alpha olefin formed by a polymerization reaction in the presence of a single site catalyst or a metallocene with Polyethylene or other polyolefin such as EVA, EMA, EAA, EMAA, ionomers, ENBA, PP or PPE.

The films of example 23 and 24 can either be single layer films or multi layer films where additional layers are present on layer 1.

WE CLAIM:

1. A structure comprising a layer of a polymer formed by the polymerization reaction with a single site catalyst.
2. The article of claim 1 wherein said structure is a film.
3. The film according to claim 2 wherein said layer comprises an ethylene polymer formed by the polymerization reaction with a single site catalyst.
4. The film according to claim 2 wherein said layer comprises a propylene polymer formed by the polymerization reaction with a single site catalyst.
5. The film according to claim 2 wherein said layer comprises a vinylidene chloride copolymer formed by the polymerization reaction with a single site catalyst.
6. The film according to claim 2 wherein said layer comprises a polystyrene formed by the polymerization reaction with a single site catalyst.
7. The film of claim 3 where said polymer is a copolymer of ethylene.
8. The film of claim 7 where said polymer is a copolymer of ethylene and a C₃-C₂₀ alpha olefin.
9. The film according to claims 1-8 wherein said single site catalyst is a metallocene.
10. The film according to claim 8 wherein said alpha olefin is butene-1.
11. The film according to claim 8 wherein said alpha olefin is hexene-1.
12. The film according to claim 8 wherein said alpha olefin

is 4-methyl pentene-1.

13. The film according to claim 8 wherein said alpha olefin is octene-1.
14. The film according to claim 8 wherein said polymeric layer is a blend of said copolymer of ethylene and an alpha olefin with a polyolefin.
15. The film according to claim 14 wherein said polyolefin is a low density polyethylene.
16. The film according to claim 14 wherein said polyolefin is a linear low density polyethylene.
17. The film according to claim 14 wherein said polyolefin is an ethylene vinyl acetate.
18. The film according to claim 14 wherein said polyolefin is a polymer of ethylene and an alpha olefin formed by the polymerization reaction with a single site catalyst.
19. The film according to claim 7-8 and 10-18 wherein said film is molecularly oriented.
20. The film according to claims 7-8 and 10-18 wherein said film is biaxially oriented.
21. The film according to claim 7-8 and 10-18 wherein said film is cross-linked.
22. The film according to claims 7-8 and 10-18 wherein said film is irradiated.
23. The film according to claims 7-8, and 10-18 further comprising a barrier layer.
24. The film according to claim 23 wherein said barrier layer is a copolymer of vinylidene chloride.

25. The film according to claim 23 wherein said barrier layer is ethylene vinyl alcohol.
26. The film according to claim 24 wherein said vinylidene chloride copolymer is a copolymer of vinylidene chloride and methyl acrylate.
27. A bag made from the film of claims 2-8, 10-18.
28. The article of claim 1 wherein said structure is a collapsible dispensing tube.
29. The tube according to claim 28 where said layer comprises an ethylene polymer formed by a polymerization reaction with a single site catalyst.
30. The tube according to claim 29 wherein said ethylene polymer is a copolymer of ethylene.
31. The tube according to claim 30 wherein said polymer is a copolymer of ethylene and C₃-C₂₀ alpha olefin.
32. The tube according to claim 31 wherein said alpha olefin is octene-1.
33. The article of claim 1 where said structure is a pouch.
34. The article of claim 1 wherein said structure is a container.
35. A structure comprising a layer of polymer formed by the polymerization reaction with a metallocene catalyst system.
36. The article of claim 35 wherein said structure is a film.
37. The film according to claim 36 wherein said layer comprises an ethylene polymer formed by the

polymerization reaction with a metallocene catalyst system.

38. The film according to claim 36 wherein said layer comprises a propylene polymer formed by the polymerization reaction with a metallocene catalyst system.
39. The film according to claim 36 wherein said layer comprises vinylidene chloride copolymer formed by the polymerization reaction with a metallocene catalyst system.
40. The film according to claim 36 wherein said layer comprises a polystyrene formed by the polymerization reaction with a metallocene catalyst system.
41. The film of claim 37 where said polymer is a copolymer of ethylene.
42. The film of claim 41 where said polymer is a copolymer of ethylene and a C₃-C₂₀ alpha olefin.
43. The film according to claim 42 wherein said alpha olefin is butene-1.
44. The film according to claim 42 wherein said alpha olefin is hexene-1.
45. The film according to claim 42 wherein said alpha olefin is 4-methyl pentene-1.
46. The film according to claim 42 wherein said alpha olefin is octene-1.
47. The film according to claim 42 wherein said polymeric

layer is a blend of said copolymer of ethylene and an alpha olefin with a polyolefin.

48. The film according to claim 47 wherein said polyolefin is a low density polyethylene.
49. The film according to claim 47 wherein said polyolefin is a linear low density polyethylene.
50. The film according to claim 47 wherein said polyolefin is an ethylene vinyl acetate.
51. The film according to claim 47 wherein said polyolefin is a polymer of ethylene and an alpha olefin formed by the polymerization reaction with a metallocene catalyst system.
52. The film according to claim 40-41 and 42-51 wherein said film is molecularly oriented.
53. The film according to claims 40-41 and 42-51 wherein said film is biaxially oriented.
54. The film according 40-41 and 42-51 wherein said film is cross-linked.
55. The film according claim 40-41 and 42-51 wherein said film is irradiated.
56. The film according to claims 40-41 and 42-51 further comprising a barrier layer.
57. The film according to claim 56 wherein said barrier layer is a copolymer of vinylidene chloride.
58. The film according to claim 56 wherein said barrier layer is ethylene vinyl alcohol.
59. The film according to claim 57 wherein said vinylidene

chloride copolymer is a copolymer of vinylidene chloride and methyl acrylate.

60. A bag made from the film of claims 35-53.
61. The article of claim 35 wherein said structure is a collapsible dispensing tube.
62. The tube according to claim 61 where said layer comprises an ethylene polymer formed by a polymerization reaction with a metallocene catalyst system.
63. The tube according to claim 62 wherein said ethylene polymer is a copolymer of ethylene.
64. The tube according to claim 63 wherein said polymer is a copolymer of ethylene and C₃-C₂₀ alpha olefin.
65. The tube according to claim 64 wherein said alpha olefin is octene-1.
66. The article of claim 35 where said structure is a pouch.
67. The article of claim 35 wherein said structure is a container.
68. The article of claim 1 wherein said layer comprises an amide polymer formed by the polymerization reaction with a single site catalyst.
69. The article claim 35 where said layer comprises an amide polymer formed by the polymerization reaction with a metallocene catalyst system.
70. The article of claims 68 or 69 wherein said amide is a nylon.
71. The film according to claim 2 further comprising a layer of HDPE on said layer of a polymer formed by the

polymerization reaction with a single site catalyst.

72. The film according to claim 71 where said polymer is a copolymer of ethylene and an alpha olefin.
73. The film according to claim 72 wherein said alpha olefin is hexene-1.
74. The film according to claim 72 wherein said alpha olefin is octene-1.
75. The film according to claim 73 or 74 wherein said polymer layer further includes a polybutylene.
76. The film according to claim 2 further comprising a layer of polyethylene terephthalate (PET) coated with a polyvinylidene chloride copolymer and an adhesive layer adhering said PET layer with said polymer layer.
77. The film according to claim 76 wherein said adhesive is low density polyethylene.
78. The film according to claim 76 wherein said film is formed by adhesive lamination.
79. The film according to claim 77 wherein said film is formed by extrusion lamination.
80. The film according to claim 2 wherein said film further comprises a second layer of an adhesive, a third or core layer of ethylene vinyl alcohol, a fourth layer of an adhesive and a fifth layer of nylon.
81. The film of claim 80 formed by means of the tubular water quench process.
82. The film according to claim 75 wherein said polymer layer further includes ethylene vinyl acetate.

83. A process for forming a structure comprising the steps of providing a layer of a polymer formed by the polymerization reaction with a single site catalyst.
84. The process according to claim 83 wherein said structure is a film.
85. The process according to claim 84 wherein said film comprises a layer of an ethylene polymer formed by the polymerization reaction with a single site catalyst.
86. The process according to claim 84 wherein said film comprises a layer of an ethylene polymer formed by the polymerization reaction with a metallocene catalyst system.
87. The process according to claims 85 or 86 wherein said film is molecularly oriented.
88. The process according to claim 87 wherein said film is biaxially oriented.
89. The process according to claim 88 wherein said film is irradiated.
90. The process according to claim 87 wherein said polymer is a copolymer of ethylene and an alpha olefin.
91. The film according to claim 24 wherein said film is biaxially oriented and irradiated.
92. The film according to claim 25 wherein said film is biaxially oriented and irradiated.
93. The film according to claim 26 wherein said film is biaxially oriented and irradiated.
94. The film according to claim 57 wherein said film is

biaxially oriented and irradiated.

95. The film according to claim 58 wherein said film is biaxially oriented and irradiated.
96. The film according to claim 59 wherein said film is biaxially oriented and irradiated.

ABSTRACT

Copolymers of ethylene and alpha olefins that have been formed by a polymerization reaction in the presence of a single site catalyst, such as a metallocene, are used as a film or as a layer in multiple layer films, including molecularly oriented and irradiated heat shrinkable films. Novel blends of the copolymers with other polymeric materials are disclosed and used as a film or a layer in a film particularly in molecularly oriented and heat shrinkable films. Bags made from the multiple layer films are especially useful for shrink packaging primal cuts of meat. Processes for the formation of flexible films and packages made therefrom are also disclosed.

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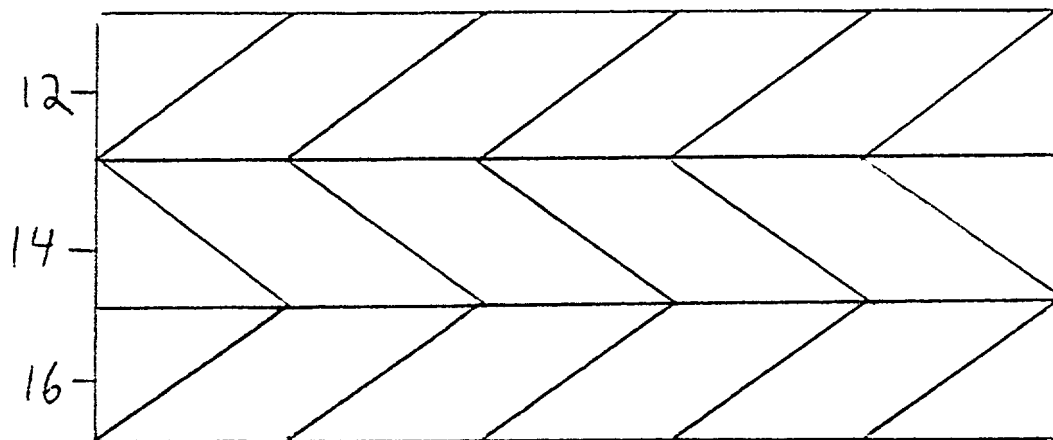


Figure 1

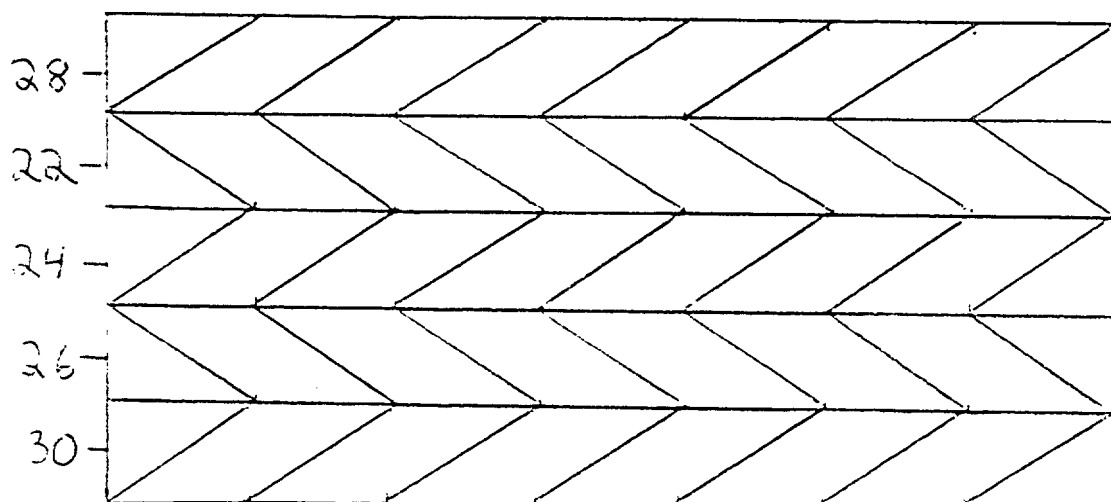
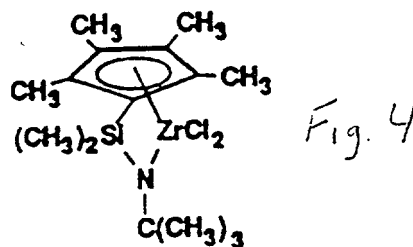
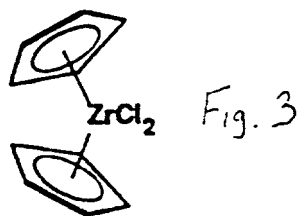


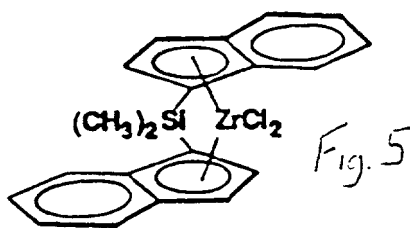
Figure 2

PRIMARY METALLOCENE CATALYSTS

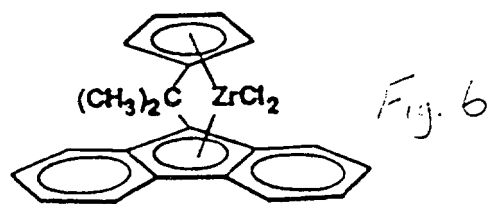
Non-Stereoselective



Stereoselective



Iso-Selective



Syndio-Selective

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

IMPROVED STRUCTURES OF POLYMERS MADE FROM SINGLE SITE CATALYSTS.

the specification of which (check one)

☐ is attached hereto.

☐ was filed on June 24, 1993 as Application Serial No. 08/082,226.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

PRIORITY CLAIMED

None
(Number) (Country) (Day/Month/Year)

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I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

None

(Application Serial No.) (Filing Date) (Status) (Patented, pending, abandoned)

(Application Serial No.) (Filing Date) (Status) (Patented, pending, abandoned)

(Application Serial No.) (Filing Date) (Status) (Patented, pending, abandoned)

And I hereby appoint: Thomas A. O'Rourke, Reg. No. 27,665; 645 Madison Avenue; New York, New York 10022; Tel.: (212) 826-0171 my attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith.

Address all correspondence and all telephone calls to Thomas A. O'Rourke.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may

jeopardize the validity of the application or any patent issued thereon.

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